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A New Method for Calculating Number Concentrations of Cloud Condensation Nuclei Based on Measurements of A Three-wavelength Humidified Nephelometer System

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The number concentration of cloud condensation nuclei (CCN) plays a fundamental role in cloud physics. Instrumentations of direct measurements of CCN number concentration (NCCN) based on chamber technology are complex and costly, thus a simple way for measuring NCCN is needed. In this study, a new method for NCCN calculation based on measurements of a three-wavelength humidified nephelometer system is proposed. A three-wavelength humidified nephelometer system can measure aerosol light scattering coefficient (σsp) at three wavelengths and the light scattering enhancement factor (fRH). The Angstrom exponent inferred from σsp at three wavelengths provides information on mean predominate aerosol size and hygroscopicity parameter (κ) can be calculated from the combination of fRH and Angstrom exponent. Given this, a look-up table that includes σsp, κ and Angstrom exponent is established to predict NCCN. Due to the precondition for the application, this new method is not suitable for externally mixed particles, large particles (e.g. dust and sea salt) or fresh aerosol particles. This method is validated with direct measurements of NCCN using a CCN counter on the North China Plain. Results show that relative deviations between calculated NCCN and measured NCCN are within 30% and confirm the robustness of this method. This method enables simpler NCCN measurements because the humidified nephelometer system is easily operated and stable. Compared with the method of CCN counter, another advantage of this newly proposed method is that it can obtain NCCN at lower supersaturations in the ambient atmosphere.